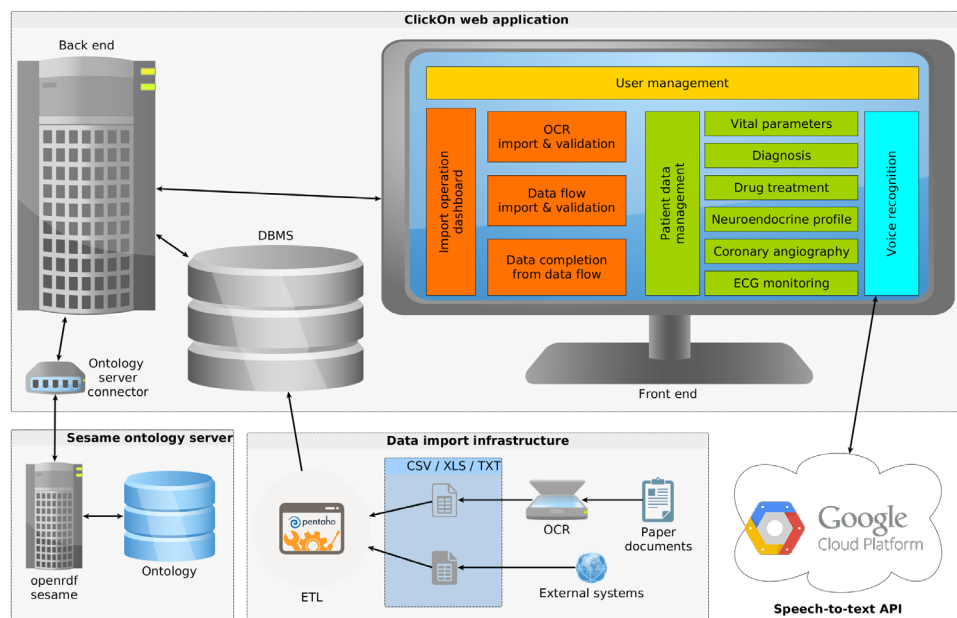


THE SYSTEM ARCHITECTURE

The technological environment of **ClickON** is completely **Open Source**:

- **Development environment J2EE** - Java Platform, Enterprise Edition
- **RDBMS** – PostgreSQL
- **Ontology Engine** - Sesame Ontology server
- **Ontology Editor** - Protégé
- **Optical Character Recognition** – Tesseract
- **Voice recognition** - Google Cloud Platform, Annyang library
- **ETL** - Pentaho Data Integration



ClickON - Overview of the system architecture

THE RESULTS

ClickON led to the creation of a prototype developed with Open Source technologies for an integrated management of clinical data in cardiology, collected in different ways - data entry web, import of electronic data flows, capture from paper forms, and data acquisition via voice. An experimentation of a semantic engine that hooks the relational model and allows the use of concepts and relationships modeled by the Ontology has been implemented. The prototype is designed for using in a clinical environment, to test the implemented features, the usability of the GUI, the linkage between the data flows collected in different ways, the accuracy and completeness of the semantic module, in order to suggest new elements for the Ontology evolution and possible future development of the platform.

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Regione Toscana

Clinical Knowledge on action: an open source web-based platform for integrated cardiological data collection



Cli K On

Clinical Knowledge On Action



ISTITUTO DI FISILOGIA CLINICA
CONSIGLIO NAZIONALE DELLE RICERCHE

EPIDEMIOLOGY AND HEALTH SERVICES RESEARCH DEPARTMENT

THE PROJECT

ClickON - Clinical Knowledge on action: an open source web-based platform for integrated cardiological data collection (<https://clickon.extrasys.it/>) is a web-based interoperable open-source platform for the integrated management of clinical cardiological data, which is the result of a research and development project co-financed by the Tuscany Region in the call POR CRo FESR 2007-2013, Line of Action 1.5.a - 1.6.

Thanks to the creation and the link to a validated medical ontology in the cardiovascular domain, the technological platform shows a concrete integration with the semantic world.

THE PARTNERS

The **ClickON** prototype has been implemented by Extra Srl in partnership with the Institute of Clinical Physiology of CNR in Pisa - Epidemiology and Health Service Research Department.

Extra srl (www.extrasrl.it) is a systems integrator specialized in the design and development of software solutions for the enterprise market, all being web-based mainly on open source technologies. Born in Tuscany in 2006, Extra srl is realizing growth in its turnover as well as number of employees with currently having about 50 employees and three offices.

The **Institute of Clinical Physiology** (<https://www.ifc.cnr.it>) is the largest biomedical research institute of the National Research Council with a specific clinical mission. In particular, the staff of the Epidemiology and Health Services Research Department (<https://epid.ifc.cnr.it>) consists of an interdisciplinary team of researchers and technologists, with strong skills in social epidemiology field.

The collaboration of Extra with IFC has been important since the planning stage of **ClickON**. The complementary expertise and experience of IFC with respect to technological expertise of Extra allowed to deepen and develop topics related to **Ontologies** in cardiovascular domain, supporting the personalized medicine.

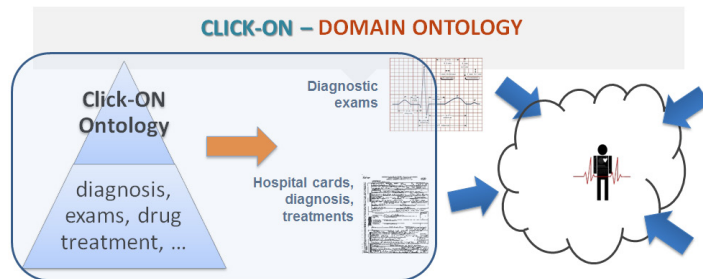


Main Entities and Relationships of the Ontology

THE PROJECT IDEA

The clinical and health information generated over the years through the contacts of patients with hospitals, the National Health Service and other health care infrastructures, are manifold. This information often cannot be properly used for creating efficient care pathways/improve treatments already in place, for reasons related to the heterogeneity of the data, which are not standardized, and different formats for gathering information (electronic, paper, voice, ...).

The variety of medical terms used in the definition of the diagnosis and treatment also suggests the opportunity of strengthen the electronic data management systems, through the use of ontological models and semantic components, in order to effectively support the clinicians and specialists in their decision making process.



ClickON Ontology and data sources

MAIN GOALS

ClickON has been designed for the management of integrated **cardiological data**, thanks to an open-source and web-based prototype, driven by a domain **Ontology**. In line with the principles of **personalized medicine** and by redefining the concept of disease - considered as a 'Process', not a 'State' - a global vision of the individual is promoted with the creation of highly customized diagnostic and therapeutic pathways.



ClickON and Personalized Medicine – Disease as a Process

Standardization and integration of data from heterogeneous sources.

Data entry via web functionalities of the prototype.

Validated domain **Ontology** and its integration into the platform.

Acquisition of data available in different formats.

- Electronic data flows (hospital discharge records, pharmaceutical, medical reports) by **ETL processes (Extraction, Transformation and Loading)**;
- information from paper (medical records, reports, etc.) using **OCR (Optical Character Recognition)**;
- Information acquired by **Voice Recognition (Speech-to-Text API)** under dictation of texts (drugs, reporting, ...);



THE FUNCTIONALITIES

The prototype provides the main interfaces for managing data via Web:

- Vital Parameters
- Neuroendocrine Profile
- Diagnosis
- Drug Treatment
- ECG Monitoring
- Coronary Angiography

Key information to be collected and the right management of values (allowed units measure, range of feasible / normal values, mandatory values, ...) have been identified thanks to a preliminary phase conducted with clinicians and epidemiologists.

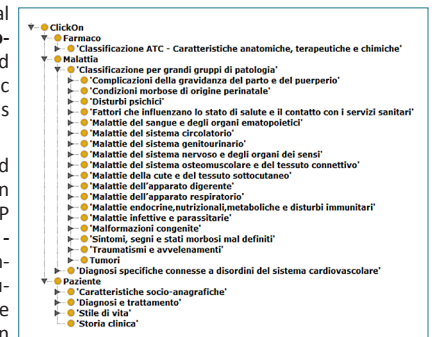
Time	Exam	Meas. Unit	Value	Institute	Update	Copy	Delete
03/06/2015	Body temperature	Degrees Celsius (C°)	37.00	IFC Pisa			
21/04/2015	Systolic Blood Pressure	Millimeters of mercury (mmHg)	30.00	IFC Pisa			
24/02/2015	Diastolic Blood Pressure	Millimeters of mercury (mmHg)	23.00	IFC Pisa			
12/10/2012	Pulse rate	Beats per minute (b/min)	2.00	IFC Pisa			
03/07/2012	Weight	Kilograms	58.00	IFC Pisa			
03/07/2012	Height	Centimeters	168.00	IFC Pisa			
07/10	Body Mass Index	Body Mass Index (decimal x/L)	20.55	IFC Pisa			
07/10	Body Surface Area	Body Surface Area (square meters)	1.65	IFC Pisa			

ClickON – Main data entry functionalities of the prototype

THE ONTOLOGY

Following a review of the scientific literature about validated medical ontologies - UMLS, ICD9-CM, MeSH, SNOMED CT -, the **ClickON Ontology** has been created with the definition of hierarchically structured entities, relationships between them and their properties. A specific focus on the diseases "*Heart Failure*" and "*Myocardial infarction*" has been implemented.

The process of validation and refinement of Ontology was performed with the involvement of opinion leaders in cardiovascular field. An additional step of validation has been carried out by means of NLP techniques (Natural Language Processing) through **T2K - Text-To-Knowledge** -, framework implemented by ILC (Institute of Computational Linguistics) of CNR in Pisa. Through the text analysis of scientific publications of reference in cardiovascular care, about the two diseases studied in depth, it was possible to validate the Ontology respect to entities, relationships and properties.



ClickON Ontology through Protégé